10/018184

JC05 Rec'd PCT/PTO 10 DEC 2001

**VERIFICATION OF TRANSLATION**

I, DAVID CLAYBERG

of 948 15th St., Ste. 4
Santa Monica, CA 90403-3134

10018184.121501

declare that I am a certified translator well acquainted with both the German and English languages, and that the attached is an accurate translation, to the best of my knowledge and ability, of the attached German Patent Application.

Signature ______________________ Date December 10,2001

David Clayberg

2/PRTS

10/018184

JC05 Rec'd PCT/PTO 10 DEC 2001

Navigation Device and Method for Controlling the Scale of a Map Detail Shown on a Display Unit of the Navigation Device

Sub A1

~~Prior Art~~

Sub A2

The invention is based on a navigation device and a method for controlling the scale of a map detail shown on a display unit of a navigation device, as generically defined by the preambles to the independent claims.

There are known navigation devices, preferably for use in motor vehicles, which have a display unit on which a road map or a detail of a road map is displayed, which shows the surroundings of the current vehicle position, as well as a marker for the current vehicle position within the map or the map detail.

Such navigation devices with map displays frequently offer the possibility of displaying different scales of the map. In this connection, the respective scale can optionally be adjusted either manually or by means of a zoom function automatically controlled by the navigation device in which the automatic system regularly selects a scale in which both the current vehicle position and the navigating destination are displayed together on the display unit.

Sub A3

~~Advantages of the Invention~~

Sub A4

By contrast, the navigation device according to the invention and the method according to the invention, with the features of the independent claims, make it possible to constantly adapt the scale of the map detail displayed on the display unit of the navigation device as a function of driving instructions.

It is thus particularly advantageous that the scale of the map detail is always selected and adapted during travel of the motor vehicle, so that the route to be traveled between the current vehicle position and the next decision point, for example a turn, is displayed completely and at the highest resolution possible on the display unit.

A step by step adaptation of the scale of the current map detail shown on the display unit as the vehicle position approaches the next decision point, which adaptation is carried out in a manner according to one exemplary embodiment of the invention, has the advantage that the display does not have to be updated continuously, which can save a considerable amount of computing power. Furthermore, a step by step scale adaptation is less confusing for the user since he does not have orient himself in relation to a constantly changing map.

The readjustment of the scale of the map detail shown on the display unit of a navigation device according to the invention as soon as the current vehicle position coincides with the decision point permits the user to promptly orient himself through the use of a map display whose scale is readjusted as a function of the distance between the current position and the next decision point.

Sub A5 ~~Drawings~~

Exemplary embodiments of the invention are shown in the drawings and will be explained in detail in the description that follows.

Fig. 1 is a block circuit diagram of the part of the navigation device according to the invention that is essential to the invention,

Fig. 2A is a flowchart of a first exemplary embodiment of the method according to the invention for adjusting the scale of the map display,

Fig. 2B is a flowchart of a second exemplary embodiment of the method according to the invention,

Fig. 3A shows an example of a first map detail shown on the display unit of the navigation device according to the invention,

Fig. 3B shows a second map detail, and

Fig. 3C shows a third map detail.

~~Description of the Exemplary Embodiments~~

Fig. 1 shows a block circuit diagram of a navigation device according to the invention for executing the method according to the invention.

A control unit 20 of the navigation device 10 according to the invention includes both the actual navigation computer as well as a display control unit 52, which among other things, serves to set the scale of a regional map or road map shown on a display unit 50 of the navigation device 10.

The control unit 20 is connected to means 30, 35, 40, which supply data regarding the position, movement direction, and movement state of the vehicle. For example, these can be a rotation speed sensor 30 which, through the integration via the detected rotation speed changes, can aid in orienting the vehicle in which the navigation device is installed in relation to the cardinal points of the compass. Alternatively, a magnetic compass can also be used to determine the orientation of the vehicle. This can also be an odometer 35 which, for example, detects pulses emitted by wheel sensors of an antilock brake system for vehicle braking and, based on the detected number of pulses and a known wheel

circumference, determines a driving distance traveled. Finally, this can also be a GPS (global positioning system) receiver 40 for receiving and evaluating radio signals emitted by GPS satellites, from which the position of the vehicle can be determined. In an alternative embodiment, the driving distance traveled can also be determined solely based on received satellite signals. It is likewise possible for the signals of the GPS receiver to be used to correct the vehicle position that has been determined based on the signals of the other sensors.

In addition, the control unit 20 has a memory 60 connected to it, which stores data of a regional map or road map in digital form. In the current exemplary embodiment, the memory 60 is embodied in the form of a CD ROM drive containing a CD ROM as a data storage device for the map data. However, the memory 60 can also be embodied in the form of a RAM or ROM semiconductor memory.

During the actual navigation process, i.e. while conducting the vehicle driver along a driving route, for example one which has been calculated before the start of the trip, the display unit 50 connected to the control unit 20 displays a map detail which contains the current vehicle position and also the next decision point, e.g. a turning point. In addition, supplementary driving instructions for the vehicle driver can also be displayed, for example in the form of a directional arrow when approaching a decision point, e.g. in the case of imminent turns, and a remaining distance before the turn. Alternatively or in addition to optically displaying driving instructions by means of the display unit 50, an audio output device 55 can also be provided, which can play audible driving instructions, e.g. "turn right after 100 meters", "now follow the highway", and the like.

In addition, the control unit 20 has an input unit 45 connected to it, which has operating elements such as push buttons 47 or other input means, e.g. rotary knobs, for inputting a navigating destination as well as for operating other functions of the device.

The navigation device according to the invention and the navigation method according to the invention function as follows.

After the navigation device 10 is switched on, the sensors 30, 35, 40, namely the rotation speed sensor 30, the odometer 35, and the GPS receiver 40, supply data from which the control unit 20 and/or the navigation computer contained in the control unit determines the current position of the vehicle in which the navigation device according to the invention is installed. Optionally, for the sake of a plausibility test, the control unit also takes into account data from the road map stored in the memory 60 in order to correct the vehicle position calculated based on the sensor data. This type of correction of the determined vehicle position is also known as "map matching".

Before, after, or even during the determination of the current vehicle position, the input of a navigating destination area or navigating destination point is executed in an intrinsically known manner, for example by alphabetically inputting an area or city name and a street name by means of the input unit 45 or for example by marking the destination by means of an indicator that is disposed on a map or road map shown on the display unit 50 and can be controlled using cursor keys.

Next, based on the current vehicle position and the destination input by the user and based on the road map data stored in the memory 60, the navigation computer calculates a driving route from the current position to the input destination.

During the actual destination seeking process, i.e. during the driving of the motor vehicle, depending on a respectively current vehicle position as the vehicle position approaches a decision point, for example an intersection, at which according to the calculated driving route, a turn must be made from a road that is currently being driven, driving instructions are generated, which are announced to the vehicle driver optically by means of the display unit 50 or audibly by means of the audio output device 55.

The function of the navigation device according to the invention and the navigation method according to the invention will be explained below with reference to the flowcharts in Figs. 2A and 2B and in conjunction with Figs. 3A, 3B, and 3C.

The process begins in step 105 with the actual destination seeking process, i.e. after the current vehicle position has been determined by means of the sensors 30, 35, and 40, a destination has been input, and a driving route from the current vehicle position to the input destination has been calculated.

The vehicle is now located, for example, on a first street 250 which, according to the calculated driving route, is to be driven until it intersects with a second street 270. According to the calculated route, a left turn should be made at the intersection, from the currently driven first street 250 onto the second street 270. The next decision point 215, at which the navigation device issues a driving instruction, is consequently the above-mentioned intersection 215 of the first street 250 and the second street 270. Just before the decision point 215 is reached, the navigation device issues a driving instruction, for example in a form with the approximate content "turn left at the next intersection".

In step 110, based on the preset area of the display unit 50 for a map display and the distance of the current vehicle position 210 from the next decision point 215, the display control unit 52 of the navigation device calculates the smallest possible scale at which the map can be shown in which both the current vehicle position 210 and the next decision point 215 can be shown on the display unit 50. The scale is thereby calculated as essentially inversely proportional to the actual distance between the current vehicle position 210 and the next decision point 215 so that the route between the current vehicle position and the next decision point can be shown in as large a format as possible on the display unit 50. Then in step 115, the map with the calculated scale and the current vehicle position 210, as well as the next decision point 215, is shown on the display unit 50. In the current map scale of Fig. 3A, the map only shows the street 250 currently being traveled, two streets 260 and 270 that cross it, including the second street 270, , as well as

the current vehicle position 210 and the decision point 215. The current map scale does not show individual lanes of the streets or how many lanes the streets have.

The process continues with step 120. There, a test is made as to whether the previous next decision point 215 has been passed yet and there is a new next decision point. If not, then the process continues with step 125. There, a test is made as to whether a preset distance has been traveled since the last test. If not, then the process goes back to step 120. The map scale is consequently not changed for the time being. Consequently, as long as the next decision point has not been reached and a preset distance has not been traveled, the map scale that is now current is maintained for the present. Thus in the current exemplary embodiment, the driver is spared having to constantly reorient himself in relation to continuously changing maps. In principle, however, it is entirely conceivable to continuously adapt the map scale to the actual distance between the vehicle position and the next decision point.

The preset distance is preferably variable and dependent on the current map scale. In addition, it can also be a function of the type of road, for example expressway, country road, or city street, or can be a function of the road density in the currently traveled area. When driving on an expressway that has a low density of exits, interchanges, or junctions, the preset distance can be on an order of magnitude, for example, of 5 to 10 kilometers; in the downtown zone, it can be on an order of magnitude of down to 10 meters.

If it is determined in step 125 that a preset distance has been traveled, then the process reverts to step 110 where a new map scale is calculated. Then, the map is displayed at the newly calculated map scale and a map detail is shown which once more contains both the current vehicle position 210 and the next decision point 215.

This situation is shown in Fig. 3B. Since the current vehicle position 210 has come closer to the next decision point 215, a smaller map scale has been selected. The currently smaller map scale permits the depiction of further details such as the several

oncoming lanes 251, 252 of the first street 250, the travel-direction lanes 253 and 254 of the first street 250, a first left-turn lane 255 for turning from the first street 250 onto third street 260 crossing it, and a second left-turn lane 256 for turning from the first street 250 onto the second street 270 crossing it, as well as the fact that the first lane 253 in the travel direction ends shortly after the intersection with the third street 260.

The display of the details described above permits the vehicle driver to orient himself so that in order to continue along the calculated driving route starting from the now current vehicle position 210, he preferably gets into the second lane 254 in the travel direction since the first lane 253 in the travel direction ends after the intersection with the third street. The vehicle driver can also orient himself and see that getting into the far left lane 255 in the travel direction would be useless because it is obviously a left-turn lane 255 for turning onto the third street. Finally, the vehicle driver can see from the current map display that as the first street 250 continues after its intersection with the third street 260, it is clearly provided with a left-turn lane for turning onto the second street 270 to follow the calculated driving route 220.

If it is determined in step 120 of the process that the next decision point 215 on the driving route 220 has been passed, then the process reverts to step 110 where the new calculation of a scale takes place in order to show the map on the display unit 50 as a function of the actual distance between the current vehicle position and the new next decision point 216. Fig. 3C shows this situation. The vehicle has turned left into the second street 270 according to the driving instructions issued by the navigation device and has thereby passed the decision point 215. The now current vehicle position 210 is on the second street 270 just after the passed decision point 215. The new next decision point 216 marks the point at which a fourth street 280 feeds into the second street 270 from the right, where a right turn should be made according to the calculated driving route.

Fig. 2B shows a flowchart of a second exemplary embodiment of the method according to the invention, which will be explained next.

The process begins in step 150 with the actual destination seeking process, i.e. after the current vehicle position has been determined by means of the sensors 30, 35, and 40, a destination has been input, and a driving route from the current vehicle position to the input destination has been calculated.

The vehicle is once again located, for example, on the first street 250, which according to the calculated driving route, is to be followed until an intersection with a second street 270. According to the calculated driving route, a left turn should be made at the intersection from the first street 250 currently being driven into the second street 270. The next decision point 215 at which a driving instruction is issued by the navigation device is consequently the above-mentioned intersection 215 of the first street 250 with the second street 270. Just before the decision point 215 is reached, the navigation device issues a driving instruction, for example in a form with the approximate content "turn left at the next intersection".

Then in step 155, the control unit 20, or the display control unit 52 as part of the control unit 20 of the navigation device 10, initially selects the largest possible scale provided for the map display with which the map can be shown on the display unit 50, containing both the current vehicle position 210 and the next decision point 215. But for the time being, the selected map detail is not shown on the display unit 50.

In another form of this exemplary embodiment, though, the map can also be already shown on the display unit 50 at this point, namely after the largest possible map scale has been set.

Then in step 160, based on the preset dimensions of the area available for a map display on the display unit 50 and the distance of the current vehicle position 210 from

the next decision point 215, a test is made as to whether the map scale can be reduced by a preset factor, provided that both the current vehicle position and the next decision point can be displayed on the map detail then selected. If so, then in step 165, the map scale is reduced by the preset factor, for example halved, so that for example instead of a scale of 1 : 500,000, a scale of 1 : 250,000 is selected. Other preset map scales for a reduction might include, for example, 1 : 100,000, 1 : 50,000, 1 : 25,000, 1 : 10,000, 1 : 5,000, 1 : 2,500, 1 : 1,000. Alternatively, though, a respective reduction by a factor of, for example, approximately 4, v2, or $^{4}$v2 is also possible. Then, the process moves to step 160, where a test is once again made as to whether the map scale can be further reduced by the preset factor. In this manner, the map scale is successively reduced as long as both the current vehicle position 210 and the next decision point 215 along the calculated driving route 220 can be shown in the selected map detail.

Finally, if a determination is made in step 160 that it is not possible to further reduce the map scale while simultaneously being able to display both the current vehicle position 210 and the next decision point 215 on one and the same map detail, then in step 170, the map detail is displayed on the display unit 50 of the navigation device 10 at the smallest possible previously determined map scale, at the predetermined resolution, as shown by way of example in Fig. 3A.

Then a test is made in step 175 as to whether the next decision point 215 has been passed in the meantime. If not, then the process reverts back to step 160 where a test is once again made as to whether in the meantime, it is possible to further reduce the map scale by a predetermined measure, while simultaneously being able to display both the current vehicle position 210 and the next decision point 215 at the reduced map scale on the display unit 50. This is the case, for example, if the vehicle on the first street 250 has come a certain distance closer to the next decision point 215 along the calculated driving route 220. Then in step 165, the map scale is reduced by a preset amount. If it is not possible to further reduce the map scale at this point, then in step 170, the map detail is displayed at the reduced map scale, as shown by way of example in Fig. 3B.

Otherwise, if it is no longer possible to reduce the map scale in step 160, then in step 170, the map detail is shown at an unchanged map scale.

If it is determined in step 175 that, as in the situation in Fig. 3B, the next decision point 215 has been passed, then in step 155 the largest possible map scale is once again selected for the time being and then is successively reduced in the manner described above to the smallest scale that permits a simultaneous display of both the current vehicle position 210 and the new next decision point 216.

In another form of the second exemplary embodiment, instead of an abrupt enlargement of the map scale to a maximum value, it can also be respectively enlarged by a preset value until both the current vehicle position 210 and the next decision point 216 can be shown at the smallest possible scale on the same map detail.

Whereas in connection with the description of the two exemplary embodiments, it has always been assumed that the map display must be able to show at least both the current vehicle position 210 and the next decision point 215 simultaneously on the display unit 50, another embodiment can require that a predetermined surrounding area of the current vehicle position 210 and/or the next decision point 215 be displayed, for example a surrounding area on an order of magnitude of approximately 5% to 10% of the total map area. This makes it easier for the vehicle driver to orient himself in the currently driven road network since landmarks possibly at the side of the road or in the immediate vicinity are also indicated on the map display.

Whereas it has been assumed up till now that the map scale is always selected so that it is possible to display both the current vehicle position 210 and the next decision point 215 on the display unit 50, in another embodiment form, this requirement can be eliminated such that for example only the next decision point has to be shown on the map display, otherwise the map scale is selected as essentially inversely proportional to the

distance of the current vehicle position from the next decision point. Fundamentally, the requirement to show the next decision point on the map detail can also be eliminated so that only the current vehicle position is shown in the selected map detail, or even neither the vehicle position nor the next decision point are shown in it. The map scale is then once again selected as essentially inversely proportional to the distance between current vehicle position and the next decision point, optionally even in preset stages.